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Developing a Research base for Intravenous Peripheral cannula re-sites (DRIP trial). A randomised controlled trial of hospital in-patients

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Abstract

Background: There is currently no high grade evidence on which to base decisions about the frequency of intravenous cannula re-sites.
Objective: To assess the safety of changing peripheral venous cannulas when clinically indicated.
Design: Randomised controlled trial.
Setting: A tertiary referral hospital in Brisbane, Australia.
Participants: Two hundred and six hospitalised patients from surgical, medical and orthopaedic wards.
Interventions: Peripheral intravenous cannulas were re-sited only when complications occurred (intervention group) or every 3 days (control group).
Main outcome measures: The primary endpoint was any unplanned cannula removal, the secondary outcome was cost.
Results: Forty six patients had unplanned removals in the intervention group compared with 41 in the control group [relative risk 1.12, 95% confidence interval 0.81–1.55 ($p = 0.286$)], a non-significant difference. Total duration of peripheral cannulation was similar in both groups (mean 123.3 h in the intervention group and 125.9 h in the control group: $P = 0.82$) but significantly more re-sites occurred in the control group (167 in intervention group, 202 in the control group: $p = 0.022$). Cost of cannula replacements in the intervention group was AUD$3,183.62 and in the control group AUD$3,837.56 ($p = 0.006$).
Conclusion: Re-siting peripheral venous cannulas when clinically indicated compared with changing them routinely every 3 days does not lead to more complications and reduces costs.

Keywords: Clinical trials; Cost and cost analysis; Infusions; Intravenous

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What is already known about this topic?

- Peripheral intravenous cannulation is the most common invasive procedure amongst hospitalised patients.

- Each time the integrity of the skin is breached there is an opportunity for invasion by pathogenic organisms.
- Current guidelines/recommendations about how often peripheral intravenous cannulas should be re-sited has not been tested using an appropriately powered randomised controlled trial.

What this paper adds

- Unplanned cannula removal rates are not affected by the length of time an individual cannula remains in situ.
- Costs are reduced when intravenous peripheral cannulas are re-sited when clinically indicated compared with re-siting every three days.

1. Introduction

Among hospitalised patients, intravenous therapy is the most common invasive procedure. It is associated with a phlebitis rate of between 2.3% and 35% (Martinez et al., 1994; Tager et al., 1983; White, 2001) and an intravenous catheter related bacteraemia rate of approximately 0.8% (Maki and Ringer, 1991). Responsibility for placement and re-siting these catheters is increasingly the duty of registered nurses, who either are part of specialised teams or who work in areas such as critical or intensive care, emergency departments or in other locations where nursing has a greater degree of autonomy in practice.

Current guidelines recommend that peripheral intravenous catheters should be re-sited every 72–96 h, in adults, to restrict infection potential (O'Grady et al., 2002), and most hospitals follow this recommendation. However, the guideline cites only one study to support the recommendation. This was a paper published in 1998 and based on data collected 15 years ago (Lai, 1998). More recent studies have challenged the need for such frequent re-sites (Homer and Holmes, 1998; Bregenzer et al., 1998; White, 2001; Cornely et al., 2002) and suggest that dwell times of intravenous cannulas may be safely extended. Most of the investigations in adults have been either retrospective or prospective observational studies based on convenience samples which may have led to sampling bias. Thus, the primary objective of the present study was to assess the safety of prolonging the time between intravenous cannula re-sites using more rigorous methods. The hypotheses for the study are:

1. That more unplanned IV cannula re-sites will occur in the 3-day change group (control group) than in the group who have their cannula changed only when a complication occurs (intervention group).
2. That the cost of IV cannulation will be greater in the control group when compared with the intervention group.

2. Method

2.1. Study population

Human Research Ethics Committee gave approval to conduct the trial. Participants were eligible for the DRIP trial if they were inpatients at the Royal Brisbane and Royal Women's Hospital, were at least 18 years of age and expected to have a peripheral venous catheter indwelling for at least 4 days. The trial was controversial as it contravened existing guidelines, so we restricted entry to those who had their cannula inserted by a nurse from the IV Therapy Team. This enabled us to standardise insertion methods and closely monitor insertion sites. We excluded patients with an existing bloodstream infection and those receiving immunosuppressive treatment. At the time of peripheral catheter insertion, all potentially eligible participants were given a trial information leaflet outlining the study. Within 72 h they were asked for their written consent.

2.2. Procedure

The intervention group had their peripheral venous catheter re-sited if clinically indicated. The control group had a new peripheral venous catheter re-located to a different site every 3 days (or when clinically indicated if less than 3 days). A member of the IV Unit was responsible for inserting all initial and replacement catheters. Demographic and other risk factors which may have been associated with an IV complication were collected at baseline. All medications and infusates were graded on an 'irritability scale' (Catney et al., 2001). The scale was modified for the study by our hospital pharmacist to include medications received by patients during the study, it ranged between 1 (least irritable) and 4 (most irritibale). If the patient was receiving more than one additive, we recorded the one with the highest irritability score. Vein quality was classified by IV Unit staff on a 6-point scale from 'extremely limited' to 'good' in line with their usual practice. Participants were monitored for the total infusion period and followed until 48 h after catheter removal or until discharge.

2.3. Primary outcome measure

We used a composite measure of any unplanned reason for cannula removal. That is, if the cannula was removed for any of the following reasons, the patient

was considered to have had an 'unplanned' cannula removal (i) leakage around the cannula; (ii) infiltration (defined as permeation of non-vesicant IV fluid into the interstial compartment, causing swelling of the tissue around the site of the catheter); (iii) erythema; (iv) occlusion/blockage; (v) pain; (vi) accidental removal; (vii) local infection at the site of the catheter (defined as erythema with cellulitis at the site or pus); (viii) phlebitis (defined as the presence of two or more of the following: pain, tenderness, warmth, erythema, swelling, and a palpable cord (Bregenzer et al., 1998; Maki and Ringer, 1991; Monreal et al., 1999) during the course of the infusion and up to 48 h after peripheral venous catheter removal) or (ix) catheter-related blood stream infection (based on the isolation of a phenotypically identical organism from a catheter segment and a blood culture (Cornely et al., 2002).

2.4. Secondary outcome measure

2.4.1. Cost

Cost was calculated in two ways, costs associated with cannulas inserted for the administration of intermittent IV medication and cost associated with IV cannulas inserted for continuous infusion. For the first group, which we estimated to be 25% of the population we calculated a total cost of AUD $14.26. This included 20 min nursing time (locating patient, preparation and insertion), a cannula, a 3 way tap, a basic dressing pack, a syringe, transparent adhesive dressing, skin disinfection and local anaesthetic per insertion. For patients receiving a continuous infusion we calculated a total cost of AUD $21.26 per insertion. This included all the above costs plus the additional cost of replacing all associated lines, solutions and additives which are discarded when a cannula is changed (ie intravenous administration set and 1 litre sodium chloride 0.09%).

2.4.2. Sample size

We based our sample size on an estimated 40% rate of unplanned cannula removals (estimate from the IV Unit leader). We calculated that a sample size of 105 in each arm of the study would be needed to detect a 50% reduction in the primary outcome measure (two tailed, $\alpha = 0.05$, power 80%).

2.4.3. Randomisation and blinding

Randomisation was by a computer generated random number list, stratified by oncology status. Allocation to the control or treatment group was made by phoning a person who was independent of the recruitment process and blind to baseline clinical data. The person assessing the outcome (a nurse from the IV Unit) was not blinded to the study group but was unassociated with the the study.

2.4.4. Statistical analysis

We conducted an intention to treat analysis. We analysed the primary outcome using the 2-sided Fisher's Exact test and results are presented as relative risks with 95% confidence intervals. A Student's *t*-test comparison of intervention versus control was used for the secondary outcome. All statistical data were analysed using SPSS (Version 12.0, SPSS, INC, Chicago, IL). The CONSORT guidelines were followed from the point of eligibility. Statistical results are all 2-tailed.

3. Results

Between April 2004 and November 2004 we assessed 1240 patients who were potentially eligible for the study. Amost half ($n = 533$) did not meet eligibility criteria and a further 501 were excluded for other reasons (Fig. 1). Table 1 shows the characteristics of the groups at baseline. Patients enrolled were mostly elderly and over half had at least 2 co-morbid medical conditions. Characteristics associated with IV cannulation are shown in Table 2. There were no statistically significant differences between groups at baseline.

3.1. Primary outcome

A total of 368 cannulas were inserted in the 206 participants. Forty six patients (44.6%) in the intervention group had an unplanned cannula removal compared with 41 (39.8%) in the control group. The result was not statistically sgnificant [relative risk 1.12, 95% confidence interval 0.81–1.55 ($p = 0.286$)]. The total duration of peripheral cannulation was similar in both groups (mean 123.3 h, SD 88.9 h in the intervention group and 125.9 h, SD 73.0 h in the control group: $p = 0.82$) but significantly more re-sites occurred in the control group (intervention group 103, control group 161: $p = 0.022$). Infiltration was the most frequent reason for removal ($n = 89$) and erythema the least frequent ($n = 4$). Phlebitis was diagnosed on only 3 occasions, twice in the control group and once in the intervention group. Each of the patients diagnosed with phlebitis had a concurrent infection (one wound infection and two with cellulitis), they were each on antibiotic therapy and their cannulas had been in situ for an average of 48.7 h (range 25–77 h). There were no reported cases of bacteremia or local infection during the study.

3.2. Secondary outcome

There was a significant difference in cost between the two groups ($p = 0.006$). The total cost of cannula changes for the 103 patients in the control group was AUD$3837.56 compared with the total cost for the 103 patients in the intervention group of AUD$3183.62.

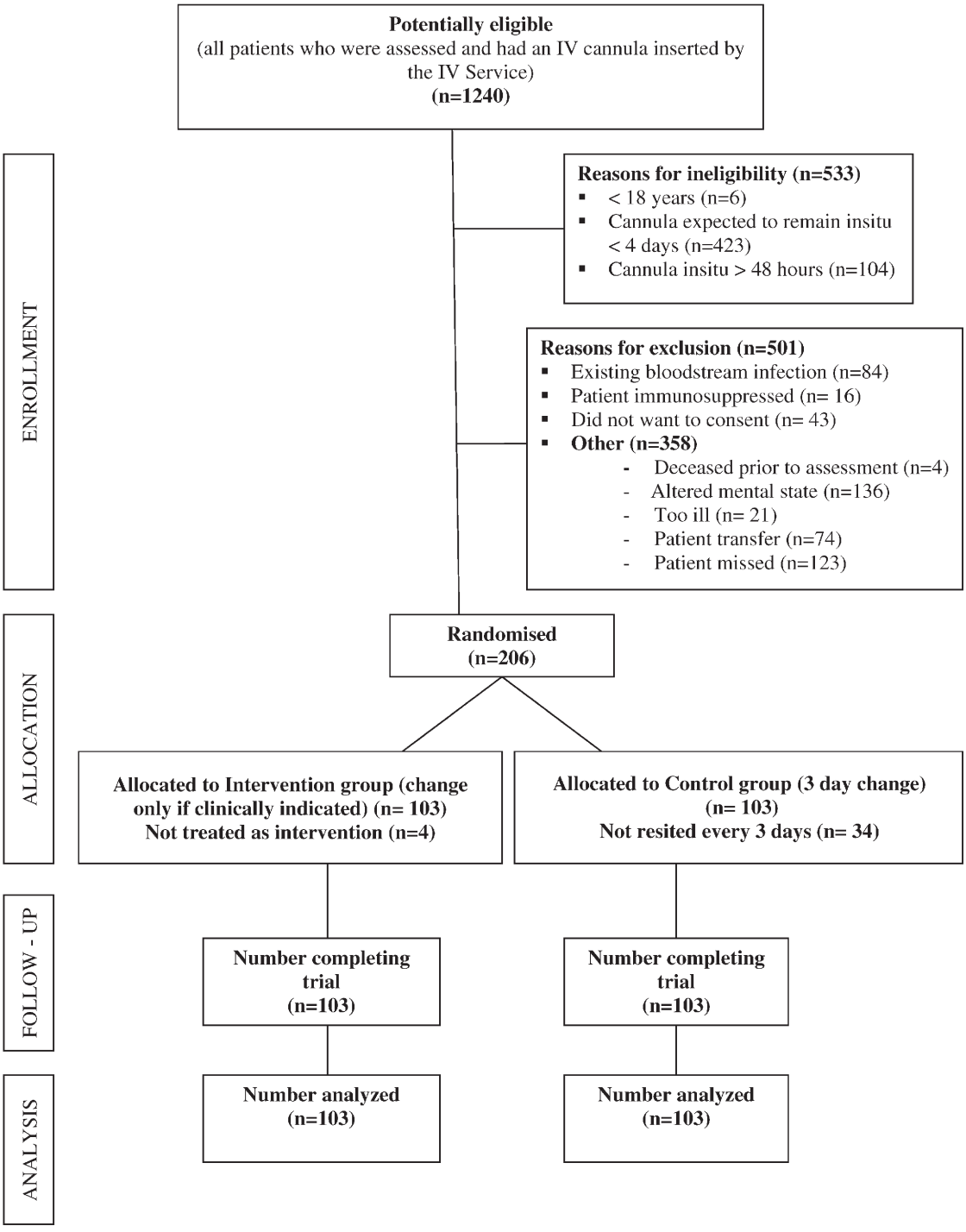

Fig. 1. Patient flow through the trial.

4. Discussion

4.1. Primary outcome

The prospective randomised controlled design of the study has allowed us to compare the effects of re-siting intravenous peripheral cannulas when clinically indicated, with the standard practice of re-siting them every three days. Outcomes were similar in both groups and this concurs with several other prospective, but not randomised studies. For example, in an adequately

Table 1
Baseline characteristics of study participants

	No-change ($n = 103$)	3-Day ($n = 103$)	P[a]
Sex[b]			
Male	50 (48.5)	49 (47.6)	0.50
Female	53 (51.5)	54 (52.4)	
Mean age in years[c]	60.22 [16.2]	63.06 [17.3]	0.22
Reason for admission[b]			
Gastrointestinal	49 (47.6)	47 (45.6)	0.99
Vascular	23 (22.3)	24 (23.3)	
Oncology	12 (11.7)	12 (11.7)	
Other	19 (18.4)	20 (19.4)	
Past medical history[b]			
Nil	11 (10.7)	6 (5.8)	0.38
1 co-morbid medical condition	27 (26.2)	28 (27.2)	
2 co-morbid medical conditions	36 (35.0)	31 (30.1)	
>2 co-morbid medical conditions	29 (28.2)	38 (36.9)	
Has current infection[b]			
Urinary tract	2 (1.9)	7 (6.8)	0.09
Respiratory tract	9 (8.7)	9 (8.7)	0.60
Wound/cellulitis	20 (19.4)	23 (22.3)	0.37
Type of surgery[b]			
Nil	46 (44.7)	41 (39.8)	0.91
Gastrointestinal	30 (29.1)	31 (30.1)	
Vascular	13 (12.6)	17 (16.5)	
Other	8 (7.8)	7 (6.8)	
>1 operation	6 (5.8)	7 (6.8)	
Most recent Hb—mean (g/dL)[c]	119.98 [19.1]	119.13 [17.0]	0.43
Past history of phlebitis[b]	5 (4.9)	3 (2.9)	0.36
Indwelling urinary catheter[b]	24 (23.3)	19 (18.4)	0.25

[a]Chi square for proportions or Student's t test for continuous variables.
[b]Results expressed as number and (percent).
[c]Results presented as mean and [standard deviation].

powered observational study, which included patients from medical wards and intensive care units, the investigators were unable to demonstrate any increased risk for phlebitis (or any of the other outcomes measured) beyond the second day (Bregenzer et al., 1998). Similarly, in retrospective study of 784 I/V starts, the rate of phlebitis on days one and two was 11.5% dropping to 3.9% by day four (Homer and Holmes, 1998). The authors concluded that "there appeared to be less risk in continuing therapy beyond the 3 day than re-starting the therapy" (p. 304). In 2001, Catney and colleagues failed to demonstrate any increase in phlebitis rates with the passage of time with failure rates being less at 144 h (1.9%) than at 72 h (2.5%) (Catney et al., 2001). Also in 2001, a prospective investigation of 305 peripheral catheters reported 10 cases of infusion phlebitis amongst patients who had their catheter in situ for less than 72 h, none were reported in patients where the dwell time was longer (White, 2001). In the same study, there were 3 cases of post-infusion phlebitis, these all occured amongst patients whose peripheral vein infusion catheter had been in place for less than 72 h. Finally, phlebitis rates amongst a high-risk population of oncology and infectious diseases patients were no different when length of cannulation was dichotomised to 3 days or less and more than 3 days (Cornely et al., 2002).

Our results also concur with studies underpinning the guideline for IV cannula replacement in children (Catney et al., 2001; Cornely et al., 2002; Shimandle et al., 1999), which states "Do not replace peripheral catheters unless clinically indicated" (O'Grady et al., 2002; p. 761).

Conversely, we are at odds with a recent randomised study where 42.3% of participants in a 'change when clinically indicated group' developed phlebitis compared

Table 2
Baseline infusion related characteristics of study participants

	No-change ($n = 103$)	3-Day ($n = 103$)	P[a]
IV cannula gauge[b]			
20 gauge	61 (59.2)	59 (57.3)	0.79
22 gauge	40 (38.8)	43 (41.7)	
Other	2 (1.9)	1 (1.0)	
Vein assessment[b]			
Poor	39 (37.9)	43 (41.7)	0.34
Fair/good	64 (62.1)	60 (58.3)	
Receiving infusate[b]	82 (79.6)	81 (78.6)	0.50
Mean irritability rating of infusate[c]	1.77 [0.9]	1.78 [0.9]	0.66
Receiving IV antibiotics[b]	64 (62.1)	56 (54.4)	0.16
Mean irritability rating of antibiotics[c]	2.51 [0.7]	2.34 [0.7]	0.62
Receiving other IV medications[b]	70 (68.0)	68 (66.0)	0.44
Mean irritability of IV medications[c]	1.42 [0.6]	1.41 [0.6]	0.85
Insertion site of IV cannula[b]			
All in hand	26 (52.0)	24 (48.0)	0.08
All in forearm	57 (57.0)	43 (43.0)	
Combination of sites	17 (34.7)	32 (65.3)	
Other	3 (42.9)	4 (57.1)	
Other vascular device in situ[b]	21 (20.4)	18 (17.5)	0.36

[a]Chi square for proportions or Student's t test for continuous variables.
[b]Results expressed as number and (percent).
[c]Results presented as mean and [standard deviation].

with 4.8% in a 2-day change group (Barker et al., 2004). However there were a number of methodological flaws with that study. It was very small; only 47 participants were included with no indication of how the sample size was determined. In addition, the principal investigator, who was not blinded to group allocation, was responsible for classifying the outcome, providing a potential for reporting bias. Additionally, the phlebitis rate in the 'change when clinically indicated group' was much higher than those reported in well-conducted clinical studies.

4.2. Secondary outcome

Costings used in our study indicate that changing cannulas only when complications occur would reduce peripheral IV-related expenditure by at least 17%. We project an annual cost benefit of approximately AUD $60,300 if cannulas re-sited by the IV Unit are replaced only when clinically indicated. Cost savings would be much higher if this policy were to be adopted in other areas of the hospital, where the IV Unit are not currently responsible for cannula changes. Our estimates were very conservative, derived from the cost of a basic saline infusion and not including the cost of any other IV additives, IV analgesics or IV antibiotics, which may need replacing along with the re-site. In trials where there are no differences between intervention and control outcomes, the option with a lower cost should be chosen. In this case, the weight of evidence from recent studies along with our own findings indicates that the practice of routine 3-day peripheral cannula changes should be re-considered, at least in settings where an IV service exists. Further research is required to test if these benefits are sustained when a cannula is inserted by other hospital staff.

4.3. Other outcomes

None of the participants in the study developed bacteremia and our phlebitis rate for cannulas inserted by the IV Unit nurses was extremely low at 1.5%. The revised Intravenous Nurses Society Standards of Practice states the incidence of peripheral vein infusion thrombophlebitis should be no more than 5% in any population (1998) (Anonymous, 2000) but most studies report higher rates (Chee and Tan, 2002; Martinez et al., 1994; White, 2001). Our low phlebitis rate prevents any meaningful correlations with risk factors but it was interesting to note that each of those with a documented phlebitis had a co-existing infection which was being treated with antibiotics. We could find only one other study reporting an association between phlebitis and an infected site remote from the cannula but, in that study,

only 5.9% of potential sources of catheter related infections were attributed to a co-existing infection (Diener et al., 1996). However there is very good evidence from the infection control literature of the relationship between wound infection and remote site infections (Edwards, 1976) and this adds plausibility to the finding. Future research in the area should include information about existing infections.

Taken together, results from recent studies, including our own, challenge the most recent guidelines which recommend replacing peripheral intravenous catheters at least every 72–96 h. (O'Grady et al., 2002). In light of recent evidence, it is perhaps timely for guidelines recommending the frequency of changes in adults to be re-visited.

4.4. Limitations

Although a large number of patients were ineligible for the study, approximately half of these were because it was not anticipated that their cannula would remain in situ for more than 3 days, or because the cannula had been in place for more than 48 h before they were able to be enrolled. Neither of these reasons should have affected the results. Of the other reasons for exclusion, having an existing blood stream infection, being immunosuppressed or being too ill to consent may impact on results being generalised. However, a large proportion of the patients we studied were quite elderly and many had a number of co-morbidities, making them a vulnerable but typical tertiary hospital population, so we believe our findings remain quite robust. A further study is about to commence in which patients excluded in the current study will be involved. Ideally, the person diagnosing any IV related complication should have been blinded to the study group.

5. Conclusion

Cannulation of peripheral veins is a painful yet necessary component of modern medical care. Frequent re-sites are distressing for patients, have a significant cost component and may lead to future venous access difficulties. The present study has shown that the risk of an adverse outcome is unaffected when cannulas are re-sited based on clinical parameters and not on routine and that cost savings may be considerable if cannulas are re-sited only when clinically indicated.

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